transport could be overcome, new entrants would undoubtedly be precluded from offering voice or other services in a substantial number of cases.

Equipment that performs transmission functions is thus "necessary" for interconnection and access to unbundled network elements. Absent collocation of those functions, new entrants simply could not provide service over their own facilities in the vast majority of cases. *Cf. UNE Remand Order* ¶ 44 ("a proprietary network element is 'necessary' . . . [if] lack of access to that element would, as a practical, economic, and operational matter, preclude a requesting carrier from providing the services it seeks to offer").

Second, transmission equipment is clearly "necessary" for "*interconnection*" and "*access*" to unbundled network elements. As explained above, the Commission has interpreted the term "access" to mean the "*use* of [any] feature, function, or capability" of the unbundled element, and the incumbent must afford access to that element that would permit the competitor to offer any telecommunications service that may be offered using that element. *Local Competition Order* ¶ 268 (emphasis added); 47 C.F.R. § 51.307(c). Moreover, the Commission has repeatedly defined the unbundled loop to include high-capacity loops and loops conditioned to provide advanced services. *See UNE Remand Order* ¶¶ 172-73, 176-77. New entrants cannot "use" the full range of features and functionalities that are inherent in the loop, however, without employing the transmission functions described above. For example, without employing a DSLAM, a new entrant cannot offer DSL services and thus could not "use" the features and capabilities of the loop that facilitate DSL services. Under the plain terms of the statute, therefore, a DSLAM is "equipment necessary for . . . access to unbundled network elements," and thus may be collocated.[10]

[10] *See also Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96-98, Comments of BellSouth Corp., pp. 34-35 (filed May 26, 1999)

Finally, even if some of these transmission functions are not themselves "necessary" for interconnection or access to unbundled network elements, any attempt by incumbent LECs to preclude CLECs from collocating such functions would be an unlawfully discriminatory term of collocation. Equipment manufacturers routinely incorporate such functions in multi-use equipment that easily fits within a standard collocation cage. As a result, the collocation of such multi-use equipment does not present any legitimate issues under the Takings Clause.

Equally important, these various functions are performed by means of highly integrated circuitry that is not separable. As a result, even if a new entrant were to attempt to disable the additional functions through software modifications (as some incumbents have insisted), the physical size of the equipment would be unchanged while the cost of the equipment would likely increase (because additional software would have to be designed and added). Therefore, an incumbent LEC's attempt either to preclude collocation of the equipment or to insist that the new entrant disable the additional functionalities would squarely violate Section 251(c)(6)'s requirement that incumbent LECs offer collocation on terms that are "just, reasonable, and nondiscriminatory." *Cf. GTE Service Corp.*, 205 F.3d at 424 (questioning whether the statute would permit collocation of equipment that "unnecessarily" included other functionalities, such as payroll or data collection functions).

2. **Switching Functionality.** The Commission should also find that incumbent LECs are required to permit physical collocation of switching functionality. As explained in the attached declaration of Anthony L. Culmone and Stephen I. Holmgren, the

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("because xDSL is a copper loop technology, the DSLAM cannot be located beyond the central office . . . [a]ll carriers, CLECs and incumbents alike, have to place DSLAMs at the end of the copper loop").

central purpose of switch functionality is to select, integrate, and manage the end user's temporary control of transmission. Culmone/Holmgren Decl. ¶ 8. Particularly for equipment that integrates switching functionality with other functions – such as remote switch modules (RSMs) and packet switches – switching ensures that carriers and end users can use unbundled loops, interoffice transport, and other incumbent LEC transmission facilities to their full extent and in an efficient manner. *Id.* ¶¶ 13-15, 24, 31. Collocation of such switching functionality is "necessary" for interconnection or access to unbundled network elements, because otherwise a new entrants' cost of providing service would rise to a point that entry using interconnection or UNEs would be precluded in some circumstances. *Id.* ¶ 25. Moreover, and in all events, because multi-use equipment providing functionality in addition to switching that is necessary for interconnection or access to unbundled elements, like RSMs and packet switches, occupy the same – or even less – collocation space than equipment without switch functions, it would be discriminatory to prohibit collocation of such equipment. *Id.* ¶¶ 28, 36.

a. Collocation of Circuit Switch Equipment (Remote Switch Modules). The Commission should permit collocation of certain circuit switch equipment, specifically remote switch modules (RSMs). RSMs are multi-functional equipment that are used in conjunction with a stand-alone, fully functional circuit switch. *Id.* ¶¶ 18-19. One of the critical functions of an RSM is to provide multiplexing and concentration functions that facilitate a competitive LEC's access to unbundled loops, so that traffic carried on those loops may be efficiently transported to and from its circuit switch. *Id.* ¶¶ 18-21.

In addition to the transmission function, the RSM, in certain instances, can also provide a switching functionality. *Id.* ¶ 19. Specifically, where a CLEC customer served by an RSM calls another customer served by the same RSM, the RSM can perform the routing necessary to interconnect two loop facilities efficiently without hauling the communications all the way back and forth from the distant, stand-alone switch.[11] Given this switching functionality, RSMs are "necessary" for access to the incumbent's unbundled network loops. *Id.* ¶¶ 22-25. If RSMs cannot be collocated at an incumbent LEC's central office, competing carriers would then be forced to incur the costs of multiplexing and "backhauling" the traffic to and from an off-site location. *Id.* ¶¶ 23. Thus, a call that, with collocated RSMs, could be completed without use of any multiplexing or transport beyond the incumbent LEC's central office would require, absent collocation, transport of traffic out of the central office, all the way to the off-site switch, and then back to the central office to its ultimate destination. *Id.* Because a significant purpose of the RSM is to avoid these backhaul costs, competitive carriers would be unlikely to deploy RSMs at all unless they could be placed in collocated space. *Id.* ¶ 27.

In certain circumstances, an RSM can allow a carrier to enter a market that it cannot economically serve with a stand-alone circuit switch. But if competing carriers cannot collocate RSMs, they will not likely enter a market at all using RSMs, and will rather wait to enter until they can deploy a fully functional switch.[12] This is not a hypothetical concern. As the Culmone/Holmgren declaration explains, certain large and sophisticated customers themselves recognize that RSMs can provide them with efficiencies in transport, and have insisted on deployment of an RSM when choosing AT&T as their provider. *See id.* ¶ 26. For such

[11] Even in these circumstances, the RSM does not perform all of the functions of a stand-alone switch. Even for intra-RSM calls on which the RSM performs routing, the stand-alone switch is still necessary to perform other functions, such as billing. *Id.* ¶ 19.

[12] As the Commission has previously recognized, competing carriers cannot currently deploy circuit switches ubiquitously because they "have not gained sufficient market share to generate switch utilization rates and economies of scale" that are sufficient, "particularly to serve the mass market." *UNE Remand Order* ¶ 260.

customers, it is undeniable that an inability to collocate RSMs will preclude competing carriers from offering service.

Second, collocation of RSMs is permissible because they can perform multiple functions while occupying no more collocated space than single pieces of equipment that provide the same transmission functionality as an RSM. Indeed, a single RSM can perform transmission functions and replace multiple DLCs, and depending on the size of the footprint, the RSM is likely to be no bigger, and perhaps even *smaller*, than the multiple DLCs it is replacing. *Id.* ¶ 28. Therefore, an incumbent LEC's prohibition on collocation of RSMs would be discriminatory and patently anticompetitive. An incumbent LEC's refusal could be based not upon any legitimate concerns regarding conservation of its central office space, but only upon its desire to force its rivals to use less efficient equipment and thereby to raise its rivals' costs.

b. Collocation of Packet Switch Functions. The Commission should also find that competitive LECs may deploy packet switch functionality in collocated space. As the Culmone/Holmgren Declaration describes, packet switches perform more than mere switching functions that are necessary to establish connectivity through a carrier's network. *Id.* ¶¶ 15, 31-34. They also perform a number of critical *transmission* functions that enable a carrier to optimize its use of the conductors (media) that it uses to transport its traffic. *Id.* The efficiencies a CLEC can attain through the use of such functionalities are similar to those ILECs achieve through the use of DLC and similar multiplexing and concentration capabilities in their transmission equipment for transport (and increasingly for loop) facilities. Furthermore, the multi-functionality implicit in packet switching devices is delivered without any incremental demand for space within a collocation. In fact, a fully-functional ATM switch occupies less than a single equipment rack- the minimum possible floor space consumption of any collocacted equipment. *Id.* ¶¶ 39, 36.

It is important to recognize that packet switches are not like circuit switches, which flexibly select a dedicated end-to-end path over transmission facilities that are used to carry a particular communication, but do not perform any optimization of the transmission facilities themselves. *Id.* ¶¶ 10-12, 31. In contrast, packet switches process communications that have been structured as small cells, each of which contains "header" information that allows the switch to determine the destination of the packet. *Id.* Because this information is available for each packet and because end-to-end paths are software defined (so physical facilities may be shared among common segments), the packet switch efficiently can place customer communications on a conductor based upon the demand for the use of a particular facility at any particular time. *See infra*, p. 60 n.109. Accordingly, packet switches are not confined to setting up dedicated paths for each communication; rather, they also increase the efficiency of the carrier's transmission facilities based upon the way they intelligently multiplex communications onto the available capacity in those facilities.[13] Culmone/Holmgren Decl. ¶¶ 10-12, 31.

A packet-switch places as much communication as possible onto a particular transmission facility. Thus, they can use more of the available capacity in the facility to handle a specific communication if there is no other "contention" for capacity at that time. Circuit switches, however, select a specific path for a particular communication and also reserve bandwidth on the transmission facilities for that communication, even if it is not needed at all times during the communication (*e.g.*, if a computer is not sending or receiving data or if there is

[13] Packet switches can be used to implement either a connection-oriented network (one with end-to-end routes are defined for the duration of the communication) or a connectionless network. Individual packets are routed individually in the latter but not the former. Culmone/Holmgren Decl. ¶ 10.

silence on a voice call). *Id.* ¶ 31. In fact, if the facilities that are available for selection by a packet switch are highly restricted, its operation is virtually indistinguishable from that of a multiplexer, which is clearly a transmission not a switching function. *See infra*, pp. 58-62; *see also Local Competition Order* ¶ 581 ("[w]e recognize, however, that modern technology has tended to blur the line between switching equipment and multiplexing equipment").

Accordingly, packet switch functionality facilitates a dramatic increase in the efficiency of a carrier's transmission bandwidth by integrating route selection functionality and the multiplexing technique known as statistical multiplexing. Culmone/Holmgren Decl. ¶ 31 (describing statistical multiplexing). As the Culmone/Holmgren declaration explains, the use of such technology can produce economic savings in transmission facilities by as much as a ratio of 20 to 1 or more. *Id.*. Equipment manufacturers today make integrated equipment that performs both statistical multiplexing and packet switching functions, and such equipment fits easily within a standard sized collocation cage. *See id.* ¶¶ 15, 29. In fact, a fully-functional ATM switch occupies less than a single equipment rack – the minimum possible floor space consumption of any collocated equipment. Thus, for the reasons described above, it would be discriminatory and anticompetitive to allow incumbent LECs to deny collocation to this multi-function equipment that is currently used by ILECs (or their data affiliates) and occupies no more space than single-function equipment. *Id.* ¶ 36.

Collocation of packet switch functions is also clearly necessary for "access" to unbundled network elements. As noted earlier, the Commission has defined the unbundled loop to include high-capacity loops and loops conditioned to provide advanced services. *See UNE Remand Order* ¶¶ 172-73, 176-77. Packet switch functions are necessary to make full use of those features and capabilities of the loop, and the inability to collocate such functions would dramatically restrict new entrants' ability to offer advanced services in competition with incumbents. For example, packet switching functionality allows competing carriers to offer services in which an end user can share dynamically its transmission capacity for voice and data traffic on a single facility connecting to the new entrant's network. Thus, a large customer that has both voice and data traffic can use packet switching functionality to eliminate transmission costs associated with inefficient and under-utilized loops. Culmone/Holmgren Decl. ¶¶ 33-34. Therefore, if CLECs are permitted to collocate packet switches, a CLEC can deploy a packet switch in a central office, and, in conjunction with additional equipment at the customer's premises, combine the customer's voice and data traffic into packets, and send both types of traffic over a single dedicated facility to the CLEC's collocated packet switch. *Id.* The packet switch would then de-multiplex and connect the cells containing voice traffic to facilities connected to the CLEC's voice network and the cells containing data traffic to facilities connected to the CLEC's separate data network. Thus, use of packet switching functionality in collocated space is also necessary for a CLEC to take advantage of the full functionality of the loop.[14]

It should also be noted that the farther away from the end user a new entrant is forced to place the statistical multiplexing function that is integrated into packet switching, the

[14] Deploying packet switches in collocated space can also improve the reliability of service that a competing carrier can provide. As just one example, a competing carrier that deploys multiple DSLAMs in a central office would ordinarily employ a dedicated transport "uplink" facility for each DSLAM to terminate the data packets onto a packet switch. Culmone/Holmgren Decl. ¶ 35. If the uplink facility suffers an outage, then the outage affects all of the customers served by the DSLAM using the uplink facility. If, however, a carrier can collocate a packet switch in an incumbent LEC central office along with the DSLAMs, the packet switch functionality can select and efficiently use an alternative facility to provide connection into and out of the collocation. *Id.* As the communication density placed on a particular service increases, so to does the need for alternate facility selection/network restoration increase, so as too assure the quality and reliability of service.

greater the "transmission penalty" the new entrant must incur. Culmone/Holmgren Decl. ¶ 33. Furthermore, the less flexibility the CLEC has in its placement of packet switching functionality, the less optimized the CLEC's network facilities will be. Therefore, absent collocation, the increase in transmission costs would be sufficiently great that new entrants would not enter markets where available facility capacity was limited or costly to obtain. [15]

Finally, the Commission and several incumbent LECs have in prior proceedings effectively acknowledged that it is necessary for CLECs to collocate advanced services equipment, including packet switches. In both the *Bell Atlantic GTE Merger Order*[16] and the *SBC Ameritech Merger Order*,[17] the Commission required the merged company to offer advanced services exclusively through a "data affiliate" and expressly required the data affiliate to own all advanced services equipment, including DSLAMs and packet switches. The Commission also required the merged company to offer collocation to any unaffiliated carrier on the same terms and conditions offered to the merged company's data affiliate. The entire premise of these conditions was that the data affiliate would seek to collocate DSLAMs and packet switch equipment in the incumbent's central office, and that new entrants would therefore

[15] As set forth above, TDM facilities themselves provide greater efficiencies than non-multiplexed communications (which is why collocation of such facilities should also be permitted). As a result, that multiplexing technology should not be foreclosed should the Commission rightfully decide that packet switching should be permitted. A carrier should have the flexibility to collocate equipment that best meets the current needs of the network architecture it has chosen to deploy and it should likewise have the right to subsequently deploy equipment that permits technological evolution of its network.

[16] *Application of GTE Corporation and Bell Atlantic Corporation*, CC Docket No. 98-184, ¶¶ 260-72 (June 16, 2000).

[17] *Application of Ameritech Corp. and SBC Communications Inc.*, CC Docket 98-141, ¶¶ 363-68 (Oct. 8, 1999), *appeal pending*, *TRA v. FCC*, No. 99-1441 (D.C. Cir.).

be assured of the ability to obtain collocation on the same terms and conditions given to the incumbent's data affiliate. *See, e.g., SBC Ameritech Merger Order* ¶¶ 363, 444.

These merger conditions provide strong evidence that packet switch functionality is in fact "necessary" for interconnection and access to unbundled network elements. The incumbent LECs obviously believe that packet switch functions and associated transmission equipment must be collocated in the central office with respect to the provision of their *own* services. Indeed, in a recent order clarifying the conditions that apply to SBC and its Project Pronto, the Commission made clear that under the proposal, SBC's advanced services affiliate should act "like an unaffiliated carrier" and "must own and seek to collocate packet switches, DSLAMs, and other equipment used to provide advanced services."[18] At a minimum, the incumbent LECs' own practices are strongly probative of the "necessity" of collocating such functions.

D. Section 251(c)(6) Requires Incumbents to Permit Collocation of Cross-Connects.

The Commission should also require incumbent LECs to permit CLECs to construct cross-connects in the central office to establish interconnection with other CLECs. The Commission originally established such a requirement in the *Collocation Order*, but the D.C. Circuit criticized the requirement on the grounds that CLEC-to-CLEC cross-connects could not be "necessary" for interconnection to the incumbent LEC. *GTE Service Corp.*, 205 F.3d at 423.

[18] Second Mem. Opinion & Order, *Application of Ameritech Corp. and SBC Communications Inc.*, CC Docket 98-141, ¶ 26 (Sept. 8, 2000) ("*Project Pronto Order*"). Indeed, the diagrams attached to this order clearly demonstrate that SBC intends to place OCDs and other transmission equipment in the central office. *See id.*, App. B & C; *see also Ex Parte Letter* from Marian Dyer, SBC, CC Docket 98-141 (filed March 22, 2000) (stating that SBC's advanced services affiliate "will virtually collocate its ATMs and other Advanced Services equipment in the ILEC central office, for use in providing both ADSL and other Advanced Services").

The Commission should recognize, however, that the statute provides two independent grounds for the cross-connect requirement.

First, the Commission has never actually based the cross-connect obligation on the "necessary" language in Section 251(c)(6). Rather, the Commission required incumbent LECs to permit cross-connects as a just, reasonable, and nondiscriminatory term of collocation. *See Local Competition Order* ¶ 594; *cf. Collocation Order* ¶ 34. As the Commission has elsewhere recognized (and the incumbents have not disputed), the duty to permit collocation necessarily carries with it other ancillary rights that may also implicate the occupation of the incumbent's property, such as an easement for CLEC workers to enter the central office to maintain their collocated equipment. Cross-connects represent a similar ancillary easement, and an incumbent's attempt to deny that right would be inherently discriminatory and unreasonable (because if the incumbent can deny CLECs the opportunity to cross-connect the incumbent would be the only LEC permitted to interconnect with all other CLECs within the central office).

Second, in some instances cross-connects are in fact "necessary for . . . access to unbundled network elements." The Commission has established that one of the features, functionalities, and capabilities of the unbundled loop is that it can be shared by two LECs – *i.e.*, one can provide voice service while another provides data services over the same loop. Third Report and Order, *Deployment of Wireline Service Offering Advanced Telecommunications Capability*, CC Docket No. 98-147 and Fourth Report and Order, *Implementation of the Local Competition Provisions of the Telecommunications Act of 1996*, CC Docket No. 96-98, 14 FCC Rcd. 20912 (1999) ("*Line Sharing Order*"). The two LECs must be interconnected, however, in order to split the traffic and route it to the appropriate LEC's network. If an incumbent LEC denies two CLECs the ability to establish interconnection within the central office, the two

CLECs would be forced to extend their lines to some other location, in order for the two networks to be interconnected (or else interconnect only with the incumbent LEC). Such an arrangement would be completely infeasible and would effectively destroy the ability of the LECs to share the lines. Thus, the ability to establish cross-connects within the incumbent's premises is "necessary" for access to the features and capabilities of the unbundled loop.

II. NEXT-GENERATION LOOP ARCHITECTURES HOLD THE POTENTIAL FOR GREAT CONSUMER BENEFITS, BUT ONLY IF COMPETITIVE LECS CAN OBTAIN ACCESS TO THE FULL FUNCTIONALITY OF LOCAL LOOPS.

The Commission has properly acknowledged that its local competition rules must periodically be reviewed and adapted to changes in technology[19] and changes in the market.[20] As discussed in Part A below and in greater detail in the attached Declaration of Joseph Riolo,[21] the technological changes that are underway in the loop plant mirror to some degree changes that have already been instituted for interoffice facilities. As incumbents implement these changes in their loop plant, Part B shows that they hold quite new and significant implications for competition. Part C demonstrates, however, that these changes do not – and cannot -- alter the basic function of a loop or competitive LECs' fundamental need for access to their customers.

[19] *See, e.g., UNE Remand Order* ¶ 199 ("incumbents face loop unbundling obligations no matter which technology they employ"). This applies to the technologies in use today -- and those to be deployed in the future. *Id.* ¶ 167 ("[o]ur intention is to ensure that the loop definition will apply to new as well as current technologies, and to ensure that competitors will continue to be able to access loops as an unbundled network element as long as access is required pursuant to section 251(d)(2) standards"); *see also Line Sharing Order* ¶ 14 ("[t]he rules and standards we adopt in this Order build on industry developments and technological advances that have occurred in the telecommunications marketplace since the advent of the 1996 Act").

[20] *See, e.g., SBC/Ameritech Merger Order* ¶ 203 ("there is sufficient record evidence . . . to demonstrate that evolving types of interconnection and access arrangements with incumbent LECs may be, or are likely to be, necessary for competitors to provide new, innovative services to consumers"); *see also Advanced Services First Report and Order* ¶¶ 23-24 (adopting strengthened collocation rules designed to remove barriers to competition in the advanced services market).

As a result, these changes also do not alter the applicable statutory construct, or the basic procompetitive principles that must underlie the development of specific competition rules. Thus, as shown in Part D, the incumbents' introduction of new loop architecture provides no legal or policy basis for the Commission to contract its current definition of the local loop, which defines that element to include "attached electronics."[22]

The Commission's rules limiting competitive LECs' access to packet switching is also directly related to the new loop architecture. As shown in Part E, those rules already recognize that access to "spare copper" loops is not a viable substitute for access to the entire capability of a loop that is provided through use of next generation architecture. Further, a review of the facts concerning the architecture and economics of remote terminals (Part F) shows that collocation at such disparate remote points is virtually always infeasible for competitive LECs. Moreover, for the reasons explained in Part G, the Commission's rules should be modified to recognize that DSLAM functionality -- especially when deployed in a remote terminal loop architecture -- performs only a multiplexing (*i.e.*, transmission enhancing rather than packet switching) function and therefore should also be included within the definition of the loop. Finally, Part G explains why the Commission's rules must assure that competitors have appropriate access to information about incumbents' proposed changes to their loop plant and be treated as favorably as affiliates in the planning process.

The incumbent LECs' traditional loop architecture relied heavily on copper loops that were sometimes supplemented by digital loop carrier ("DLC") systems and high-capacity

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[21] Riolo Decl. §§ 3A, 3B.

[22] 47 C.F.R. § 51.319(a)(1).

feeder plant. In contrast, new loop technologies enable incumbent LECs to utilize more efficient architectures that incorporate a much greater use of fiber, introduce splitting and additional multiplexing functions at remote terminals ("RTs"), and additional demultiplexing at the central office and elsewhere in incumbent LECs' networks.[23] Nevertheless, the fundamental purpose of the loop – to convey customer information between a customer's premises and the serving central office reliably and efficiently -- remains unchanged. Moreover, competitive LECs' dependence upon access to unbundled loops is likewise undiminished; indeed, if anything, it is increased.

In conducting its analysis here, the Commission must take pains to understand the competitive impacts of these technology changes. It is critical that the Commission not diminish incumbent LECs' unbundling obligations when doing so will undermine competition.[24] In particular, the incumbent LECs must not be permitted to use the natural evolution of loop plant as an excuse to subvert the pro-competitive goals of the 1996 Act. Therefore, the Commission should pay close attention not only to what is changing but also what is not. This is the only way the Commission can assure that its rules achieve the Act's stated objectives, especially the promotion of genuine, sustainable competition.

As discussed below, the fundamental constant in both the current and prospective loop architectures is that competitors need to access the transmission functionalities of the loop

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[23] AT&T provides a detailed discussion of loop plant design in the Riolo Decl. §§ 3A, 3B; *see also id.* Exhs. A, C.

[24] As the Commission knows, continued regulation of intercarrier relationships is essential to competition. Indeed, assuming that such competition develops, a desirable by-product is that it enables the Commission to refrain from active regulation of retail advanced services offerings, including those of the incumbent LECs and their affiliates. But the Commission must not let its desire to refrain from regulating *retail advanced services* enable the incumbent LECs to evade their legal responsibility to provide unbundled access to their *bottleneck facilities*.

in order to collect and transport their customers' voice and data traffic, including the electronics that allow them to manage the transmission of that traffic. To accomplish this goal up to this point, it was sufficient for competitors just to access the "dumb" copper loop and use that loop to transport signals to the competitors' collocation space, where competitors could place their own electronics or access the incumbent's electronics, thus allowing them to manage the signals and take advantage of the loop's capabilities to provide the services they sought to offer. New service demands, however, dictate a more efficient loop design that places these electronics closer to the retail customer, and the ILECs are moving quickly to place that equipment in remote terminals. However, as demonstrated below, there is no means for allowing widespread industry access to those remote terminals in a practical and economic manner. Therefore, the Commission must ensure that competitors' access to loops passing through remote terminals includes access to all of the capabilities inherent in electronics deployed in the remote terminal. By doing so, the Commission will ensure that competitors have the same ability as incumbent LECs (and their data affiliates) to manage the loop and take advantage of all of its capabilities to offer competitively viable services.

A. The Components of the Local Loop Are Changing.

Sound public policies must be grounded in technological and market realities. Devising the right local competition rules for RT architectures requires an understanding of both the traditional loop paradigm and the "next-generation" paradigm. There are several important differences, but there are also at least equally important similarities.

The main characteristics of the traditional model were (1) a pair of "dumb" copper wires connecting the customer to the central office, which in turn were connected at the central office to (2) equipment that provided functionality, including circuit switches, test capabilities, new switching software, and out-of-band network signaling.[25] In various places, for particular customers, incumbent LECs also used multiplexing technologies, with devices at the customer premises and corresponding devices at the central office, but the basic model was a dumb copper loop with central office-based electronics.[26]

The traditional loop model includes the use of DLC equipment in the incumbent LECs' outside plant, which increased loop transmission performance and efficiencies by allowing the incumbent LECs to convert analog signals to digital and multiplex them onto higher capacity feeder facilities.[27] The Commission quickly recognized that these developments, especially the incumbent LECs' use of integrated digital loop carrier ("IDLC"), could impede competitors' ability to access customers' local loops. Accordingly, the Commission adopted rules intended to assure that the multiplexing of feeder plant to realize transmission efficiencies would not preclude competition, at least for voice services.[28] In particular, the Commission required that competitive LECs have access to spare copper loops (where available).[29] Moreover, whenever incumbent LECs used universal DLC plant, the Commission -- and even the incumbent LECs -- simply assumed that the multiplexing (and demultiplexing) associated with those capabilities was part of the loop functionality.[30]

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[25] Riolo Decl. ¶ 17.

[26] *Id.*

[27] *Id.* ¶¶ 20-22.

[28] *See Local Competition Order* ¶ 383; *UNE Remand Order* ¶ 175.

[29] *See UNE Remand Order* ¶ 174 (concluding that "both copper and fiber alike represent unused loop capacity. We find, therefore, that dark fiber and extra copper both fall within the loop network element's 'facilities, functions, and capabilities'").

[30] *See id.* ¶ 175.

These models were based on the technologies available at the time, and by and large they were designed to enable competitive LECs to deliver the capabilities consumers wanted. But the capabilities of loop technologies have now grown significantly, and so have consumers' needs and expectations as they have become aware of the additional capabilities the incumbent LECs' loops can provide. As a result, both supply-side and demand-side considerations are now driving the evolution of the incumbent LECs' networks. The question is whether ILECs should be permitted to wall off such improvements from the reach of CLECs by seeking changes in the essential definition of the loop. The nondiscrimination requirements of Section 251(c)(3) and the Commission's implementing rules foreclose any such attempt, which would seriously hinder competition for both voice and advanced data services.[31]

The traditional incumbent LEC architecture was largely designed to handle voice communications, and its distribution plant currently uses principally analog technology, as did most feeder plant until recently. This architecture could also, as it happens, accommodate limited data transmissions, but even with significant gains in modem technology data rates have been limited to 56 kbps (nominally) in best-case configurations.[32] Today, as the Commission is well aware, consumers increasingly desire the capability to download information from the Internet at much higher speeds.[33] Increasingly rich graphics, streaming audio, and now even streaming video applications are driving users to demand more and more bandwidth.[34]

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[31] *See also* Section 706(a) of the 1996 Act.

[32] Riolo Decl. ¶ 23.

[33] *See First 706 Report* ¶ 86 ("[a]t present, the demand for high-speed Internet access is the primary driver of consumers' desire for broadband").

[34] *See Second 706 Report* ¶ 2.

These capabilities are not easily met with the copper loop architecture. In particular, noise and other signal impairments constrain transmission rates on longer loops.[35] Some loops are so long that they cannot support commonly-used xDSL technologies at all; others are constrained to xDSL rates that are still well below what is needed to take full advantage of the possibilities of the Internet.[36]

Fortunately, technologies are now available to deliver the desired capabilities. Recent advances in digital signal processing, opto-electronics, large-scale and very large-scale integration, environmental hardening, and even power supplies have combined to place high bandwidth capabilities within the reach of millions of consumers.[37] These developments have enabled incumbent LECs to implement a prospective loop architecture that generally has the following characteristics:

- Loop plant equipment that is compatible with equipment at the customer's premises and interoperates to separate a single copper facility into high and low frequency channels, permitting high-speed transmissions above the traditional voice band;
- Much shorter runs of copper between the customer's premises and the first point at which customer information is handled by transmission electronics;
- Electronics (and opto-electronic conversion) at the RT, where all signals from the customer's premises are converted to a digital format;
- Separate multiplexing strategies for customer data and voice streams at the RT;[38]
- Fiber between the RT and the incumbent LEC central office (or other incumbent LEC location), permitting efficient high bandwidth transmission of signals; and
- Electronics at the incumbent LEC end of the loop to demultiplex the aggregated traffic, and terminate traffic on appropriate service delivery networks -- voice

[35] Riolo Decl. ¶ 26.

[36] *Id.*

[37] *Id.* ¶¶ 27-28.

[38] The voice and data streams are multiplexed differently. The former uses time division multiplexing, while the latter uses statistical multiplexing. Riolo Decl. ¶¶ 20-32.

traffic to circuit-switched networks and data traffic to packet switched networks that, in turn, provide connectivity to ISPs and other data networks.

An important feature of this architecture is that it permits customer information to be handled in a manner that accounts for the differing characteristics (and needs) of voice and data traffic. For example, data traffic requires high information density but is (somewhat) tolerant of latency. In contrast, voice traffic is low density but extremely intolerant of latency.[39]

The RT architecture also represents the next logical step in the trend toward digitization that has been underway for many years in the interoffice transmission network. Much voice traffic in the long distance network has been carried in a digital form for quite some time, and all long distance traffic has been multiplexed onto very high capacity fiber transmission facilities.[40] Now, incumbent LECs are taking similar and necessary steps to maximize the efficient use of loop bandwidth. In particular, statistical multiplexing (for voice and particularly data) is moving closer to the customer and is being used in conjunction with time division multiplexing (for voice) to improve the transmission capacities of loop plant.[41] As a result, the voice signal is digitally encoded beginning at the RT, while data signals (assuming the use of xDSL) can be digital all the way from the customer's PC.

These are significant changes. But as shown below, they do not -- and cannot -- alter competitive LECs' need for reasonable, nondiscriminatory and technically feasible access to their customers, nor do they change the applicable legal analysis and the public policy

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[39] This is why statistical multiplexing works for data but time division multiplexing works for voice. Riolo Decl. ¶ 32.

[40] *See* Steve Baraca, *The Depreciation of the PSTN*, America's Network Telecom Investor Supplement, June 1, 1999.

[41] *See* Riolo Decl. ¶ 32 & n.13.

justifications that require Commission to assure that its unbundling rules enable competitive LECs to access the full features, functions, and capabilities of the incumbent LECs' loops.[42]

B. The Evolving Loop Architectures Substantially Affect Prospects for Competition.

The evolving hybrid fiber/copper loops, including RTs equipped with next generation products, hold the potential for great consumer benefits. If, however, competitive LECs' ability to access all of the functionalities of loops provided through the use of next generation transmission equipment is not assured, only the incumbent LECs will be able to offer consumers the full range of such benefits, and competition will be significantly impaired. Prompt action by the Commission to implement procompetitive rules that are mandated by the Act can help assure that consumers will benefit *both* from a wider range of services *and* from a wider range of service providers.

One major benefit of remote terminal deployment of transmission electronics is that more consumers can obtain xDSL services. With the traditional all-copper loop, approximately 20 percent of all customers, and an even higher percentage of customers in rural areas, are located more than 18,000 feet from a central office, which is the current technical limit for access to ADSL service.[43] Where RTs are deployed to shorten copper subloops, these

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[42] *See* 47 U.S.C. § 153(29) (defining the term "network element" to include the "features, functions, and capabilities" provided by means of a "facility or equipment" used in "transmission, routing or other provision of a telecommunications service"); *Local Competition Order* ¶ 258 ("[w]e adopt the concept of unbundled elements as physical facilities of the network, together with the features, functions, and capabilities associated with those facilities"); *UNE Remand Order* ¶ 175 ("[t]he definition of a network element is not limited to facilities, but includes features, functions, and capabilities as well").

[43] The Commission has already recognized that DSL service is distance sensitive. *Second 706 Report* ¶ 38 (*citing General Introduction to Copper Access Technologies*, (visited Aug. 1, 2000) <http://www.adsl.com/general_tutorial.html>). Symmetrical DSL ("SDSL") customers must be between 10,000 and 12,000 feet of the central office depending on the speed of the service in question. *Id.*

customers can be reached with xDSL offerings and the quality of service delivered may even be superior to that available to customers who are located closer to the incumbent LEC's central offices.

RT deployment of transmission equipment enables carriers to provide new and better services to customers who can already obtain xDSL services.[44] Because noise and other signal impairments on copper facilities are exacerbated as loops increase in length, potential transmission rates on copper loops are inversely related to distance. Thus, as demonstrated in the table below, ever-shorter runs of copper translate into ever-higher digital transmission speeds.[45]

Data Rate	**Distance**
1.544 Mbps	18,000 ft.
2.048 Mbps	16,000 ft.
6.312 Mbps	12,000 ft.
8.448 Mbps	9,000 ft.
12.960 Mbps	4,500 ft.
25.920 Mbps	3,000 ft.
51.840 Mbps	1,000 ft.

As consumers increasingly seek audio streaming, video streaming, and perhaps soon even video-on-demand, the RT architecture will be of enormous benefit in supplying the bandwidth that will permit consumers to derive maximum value from the telephone network.

For all of these reasons, AT&T strongly supports continued modernization of the incumbent LECs' networks and, in particular, the use of hybrid fiber/copper loops with transmission electronics deployed in RTs. Thus, the question is not whether these technologies

[44] Riolo Decl. ¶¶ 37-38, 87-89 (emerging services that require very high transmission rates can be accommodated through the use of very high data rate ("VDSL") technology when the copper segment is shorter than 4,500 feet).

[45] *See General Introduction to Copper Access Technologies*, at http://www.adsl.com/general_tutorial.html (last visited Oct. 10, 2000).

have the potential to benefit consumers but whether they will be provided under rules that promote competition -- or stifle it.

If new entrants can obtain efficient access to the full capabilities of the loop (including RT-deployed electronics), they will be able to offer consumers an attractive array of services in competition with incumbent LECs (and their data affiliates). This will give competitive LECs a much better chance of competitive success than if they are limited to offering only POTS, while incumbent LECs can offer bundled voice/data packages to the same customers. Conversely, if changes in loop technology are implemented in ways that constrict competitors' access to loop capabilities, then new entrants will inevitably be relegated to inferior consumer offerings, or forced to pursue costly -- and probably futile -- efforts to operate out of the RT. The resulting effects on competition would be devastating.[46]

C. Continuation of Competitive LECs' Right to Access to All the Capabilities of Local Loops Is Vital to the Development of Competition, Because The Use of Next Generation Technology Does Not Change a Loop's Basic Functionality.

Loop technologies are changing, but new entrants' dependence on access to the incumbent LECs' loop facilities is not. In formulating its rules and policies for "next-generation" architectures, the Commission must base its decisions on an understanding of the evolving technological characteristics supporting the loop functionality, as well as a realistic appraisal of the effects different policy choices will have on the prospects for competition. Indeed, the Commission has already found that "[b]ecause incumbent LECs either currently do, or in the future will, compete with other providers of advanced services, they have an incentive to discriminate against companies that depend on them for evolving types of interconnection and

46 *See SBC/Ameritech Merger Order* ¶ 190 ("[i]ncumbent LECs in general have both the incentive and ability to discriminate against competitors in incumbent LECs' retail markets. This observation is the fundamental postulate underlying modern U.S. telecommunications law").

access arrangements necessary to provide new services to consumers."[47] Thus, the Commission must prevent such discrimination by establishing and enforcing rules that enable competitors to provide consumers with real and viable competitive alternatives. As shown below, nothing about the incumbents' introduction of next generation technology changes the basic functionality of a loop. Therefore, the Act and the Commission's prior decisions require that competitors continue to have access to the entire loop and all of its functionalities, no matter what technology the incumbents use to provide them.

The loop has been and will remain the network element that has the most profound monopoly characteristics.[48] The capabilities of the loop may be more fully realized as different technologies are introduced to loop plant, but the most fundamental characteristics of the loop remain exactly the same, because the loop is, and will continue to be:

- the essential pathway between the customer's premises and the central office;[49]
- the network element most difficult for competitors to replicate; [50] and
- the network element that is most crucial for competitive LECs to obtain on an unbundled basis.[51]

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[47] *SBC/Ameritech Merger Order* ¶ 202; *see also id.* ¶ 196 ("[i]n the retail market for advanced services, incumbent LECs can engage in discriminatory conduct with respect to competitors' provision of services such as xDSL by refusing to cooperate with competitors' requests for the evolving type of interconnection and access arrangements necessary to provide new types of advanced services").

[48] See *Local Competition Order* ¶ 378 (the loop has the strongest bottleneck characteristics of any network element and presents the most formidable entry barrier to the local exchange market); *see also Line Sharing Order* ¶ 37 ("self provisioning entire loops is not a viable alternative to the incumbent's unbundled loop because replicating an incumbent's vast and ubiquitous network would be prohibitively expensive and delay competitive entry"); *UNE Remand Order* ¶ 182 (same).

[49] *See Local Competition Order ¶ 380; UNE Remand Order* ¶ 166-67.

[50] *UNE Remand Order* ¶ 211 ("loop facilities, including subloop elements, are the most time-consuming and expensive network element to duplicate on a pervasive scale").

The function of the loop between the subscriber's premises and the central office is simple, but vital: it supplies the transmission functionality necessary for a retail customer to send and receive information between his/her location and the network of the service provider.[52] Thus, even with so-called next-generation technology, the loop's essential functionality remains the same: it is a transmission pathway. Moreover, the network configuration is straightforward -- it consists of conductor (generally a copper pair) from a customer's premises to a point of interface with a second conductor (increasingly fiber) connecting to the central office,[53] and transmission electronics that interface with the conductors and permit the efficient use of those media.[54] Remotely deployed transmission electronics interoperate with central office equipment to maximize the efficiency of the feeder facilities and may also interoperate with customer premises electronics to increase the efficiency of the distribution facility. These electronics are largely, if not exclusively, responsible for: (i) determining how much information a customer can transmit/receive per unit of time; (ii) controlling communications with the service provider's network; and (iii) determining the efficiency (and therefore the cost) of facility use.[55] In addition

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[51] *Local Competition Order* ¶ 378 ("[w]ithout access to unbundled local loops, new entrants would need to invest immediately in duplicative facilities" that "would likely delay market entry and postpone the benefits of local telephone competition for consumers"); *see also UNE Remand Order ¶ 182; Line Sharing Order* ¶ 37.

[52] *See Local Competition Order* ¶ 380 ("[w]e further conclude that the local loop element should be defined as a transmission facility between a distribution frame, or its equivalent, in an incumbent LEC central office, and the network interface device at the customer premises").

[53] Riolo Decl. ¶¶ 42-46. As explained in detail in the Riolo declaration, CLECs should be permitted maximum flexibility, within broad engineering parameters, to request all technically feasible fiber feeder capabilities as part of their request of an entire loop. This would include requests for any technically feasible fiber transmission media and all technically feasible transmission speeds and quality of service classes. Riolo Decl. ¶ 46.

[54] Riolo Decl. ¶¶ 48-64; Frontera/Hill Decl. ¶¶ 20, 21.

[55] Riolo Decl. ¶¶ 48-64

(and as before), means to terminate and cross-connect facilities and equipment are provided at various secured points along the loop.

In sum, none of the changes that are being made in loop technologies alter the basic transmission functions -- or the bottleneck qualities -- of the local loop.

D. The Act and the Commission's Prior Decisions Require that the Definition of the Local Loop Include Attached Next Generation Electronics.

In the Notice, the Commission asks, in effect, whether electronics that modify the loop's operational parameters should be excluded from the definition of the loop. In particular, the Commission asks whether "multi-functional" equipment (*i.e.*, equipment used for voice and data) or loop electronics used "exclusively" or "primarily" for the provision of advanced services should be excluded from the definition of the loop.[56] The answer is an unequivocal no. There is simply no authority -- and no reason -- for the Commission now to depart from the traditional statutory and regulatory principles associated with the unbundled loop element. Indeed, adoption of a service-based, or technology-based, standard as a means to balkanize the UNE loop cannot be squared with the Act or the Commission's existing rules.

The Commission has made clear that competitors' right of access to the unbundled loop element under section 251(c)(3) is independent of *both* the type of services offered *and* the technologies used to provide telecommunications services.[57] First, the Commission expressly found that there is "no basis for placing a restriction on what services a carrier may offer using the loop network element."[58] Moreover, it has clearly concluded that

[56] *See Fifth FNPRM* ¶¶ 122-123 (rel. Aug. 10, 2000).

[57] *UNE Remand Order* ¶ 177; *Local Competition Order* ¶¶ 356-365.

[58] *UNE Remand Order* ¶ 177. In any event, the deployment of new technology makes placing service distinctions upon the unbundled loop element impractical. Increasingly, new technologies are breaking down the notion that voice and data services must be necessarily